September 6, 2013

Mr. Pedro Salas, Director of Regulatory Affairs
AREVA NP Inc.
3315 Old Forest Road
P.O. Box 10935
Lynchburg, VA 24506-0935

SUBJECT: U. S. EVOLUTIONARY POWER REACTOR DESIGN AIRCRAFT IMPACT ASSESSMENT INSPECTION, NUCLEAR REGULATORY COMMISSION INSPECTION REPORT NO. 05200020/2013-202

Dear Mr. Salas:

From July 22, 2013, through July 26, 2013, the U.S. Nuclear Regulatory Commission (NRC) conducted an inspection of the AREVA Aircraft Impact Assessment related to activities conducted in support of your application. The NRC staff performed this inspection at the AREVA facility located in Lynchburg, VA. The purpose of the inspection was to assess AREVA's compliance with the provisions of Title 10 of the *Code of Federal Regulations* (10 CFR) 50.150, "Aircraft Impact Assessment." The enclosed report presents the results of this inspection.

Based on the inspection samples, the NRC inspection team concluded that AREVA met the requirements of 10 CFR 50.150 and the team did not identify any violations within the scope of this inspection.

In accordance with 10 CFR 2.390, "Public Inspections, Exemptions, Requests for Withholding," which is part of the NRC's "Rules of Practice," a copy of this letter and its enclosures will be made available electronically for public inspection in the NRC Public Document Room or from the NRC's Agencywide Documents Access and Management System, which is accessible from the NRC Web site at http://www.nrc.gov/reading-rm/adams.html. This letter and its enclosures will be withheld for 5 days from the date of issuance to allow you to identify any information you consider to be proprietary or sensitive. If you consider any information in this letter or its enclosures to be proprietary or sensitive, you must submit a timely request for the NRC to withhold that information in accordance with 10 CFR 2.390.

Sincerely,

/RA/

Richard A. Rasmussen, Chief
Electrical Vendor Inspection Branch
Division of Construction Inspection
and Operational Programs
Office of New Reactors

Docket No.: 05200020

September 6, 2013

Mr. Pedro Salas, Director of Regulatory Affairs
AREVA NP Inc.
3315 Old Forest Road
P.O. Box 10935
Lynchburg, VA 24506-0935

SUBJECT: U. S. EVOLUTIONARY POWER REACTOR DESIGN AIRCRAFT IMPACT ASSESSMENT INSPECTION, NUCLEAR REGULATORY COMMISSION INSPECTION REPORT NO. 05200020/2013-202

Dear Mr. Salas:

From July 22, 2013, through July 26, 2013, the U.S. Nuclear Regulatory Commission (NRC) conducted an inspection of the AREVA Aircraft Impact Assessment related to activities conducted in support of your application. The NRC staff performed this inspection at the AREVA facility located in Lynchburg, VA. The purpose of the inspection was to assess AREVA's compliance with the provisions of Title 10 of the *Code of Federal Regulations* (10 CFR) 50.150, "Aircraft Impact Assessment." The enclosed report presents the results of this inspection.

Based on the inspection samples, the NRC inspection team concluded that AREVA met the requirements of 10 CFR 50.150 and the team did not identify any violations within the scope of this inspection.

In accordance with 10 CFR 2.390, "Public Inspections, Exemptions, Requests for Withholding," which is part of the NRC's "Rules of Practice," a copy of this letter and its enclosures will be made available electronically for public inspection in the NRC Public Document Room or from the NRC's Agencywide Documents Access and Management System, which is accessible from the NRC Web site at http://www.nrc.gov/reading-rm/adams.html. This letter and its enclosures will be withheld for 5 days from the date of issuance to allow you to identify any information you consider to be proprietary or sensitive. If you consider any information in this letter or its enclosures to be proprietary or sensitive, you must submit a timely request for the NRC to withhold that information in accordance with 10 CFR 2.390.

Sincerely,

/RA/

Richard A. Rasmussen, Chief
Electrical Vendor Inspection Branch
Division of Construction Inspection
and Operational Programs
Office of New Reactors

Docket No.: 05200020
Distribution:
See next page

ADAMS Accession No.: ML13238A319 *concurred via email

OFFICE	NRO/DCIP/EVIB	NRO/DSRA/BPTS	NRO/DSRA/BPFP	NRO/DSRA/BPFP	NRO/DE/SEB2
NAME	EHuang	LWheeler	RVettori	RNolan	GThomas
DATE	08/27/2013	08/27/2013	08/27/2013	08/27/2013	08/27/2013
OFFICE	NRO/DCIP/EVIB	NRO/DNRL/LB1	NRO/DE/SEB2	NRO/DSRA/BPTS	NRO/DSRA/BPFP
NAME	SSmith	JSegala	Jim Xu	EMcKenna	ADias
DATE	08/28/2013	08/29/2013	08/29/2013	08/29/2013	08/29/2013
OFFICE	NSIR/DSO/ISB	NRO/DCIP/EVIB			
NAME	BStapleton	RRasmussen			
DATE	08/30/2013	09/ /2013			

OFFICIAL RECORD COPY

SUBJECT: U. S. EVOLUTIONARY POWER REACTOR DESIGN AIRCRAFT IMPACT ASSESSMENT INSPECTION, NRC INSPECTION REPORT NO. 05200020/2013-202

Distribution:

BThomas
ASnyder
SLee
EHuang
KKavanagh
TFord
ERoach
RVettori
JSegala
LWheeler
GThomas
JXu
EMcKenna
RNolan
RidsAcrsAcnwMailCenter
Dennis.Williford@areva.com
FAkstulewicz
MCaruso
DAndrukat
LDudes
RidsOgcMailCenter
Ray.Lewis.ext@areva.com
Len.Gucwa.ext@areva.com

DC AREVA – U.S. EPR Mailing List (Revised 03/25/2013)
cc:

Dr. Charles L. King
Licensing Manager, IRIS Project
Westinghouse Electric Company
Science and Technology Department
20 International Drive
Windsor, CT 06095

Mr. Robert E. Sweeney
IBEX ESI
4641 Montgomery Avenue
Suite 350
Bethesda, MD 20814

Mr. Gary Wright, Director
Division of Nuclear Facility Safety
Illinois Emergency Management Agency
1035 Outer Park Drive
Springfield, IL 62704

DC AREVA – U.S. EPR Mailing List

Email
alau@washdc.whitecase.com (Albie Lau)
APH@NEI.org (Adrian Heymer)
awc@nei.org (Anne W. Cottingham)
bgattoni@roe.com (William (Bill) Gattoni))
Brian.Vance@areva.com (Brian Vance)
cwaltman@roe.com (C. Waltman)
david.hinds@ge.com (David Hinds)
david.lewis@pillsburylaw.com (David Lewis)
dennis.williford@areva.com (Dennis Williford)
erg-xl@cox.net (Eddie R. Grant)
Gayle.Elliott@areva.com (Gayle Elliott)
gcesare@enercon.com (Guy Cesare)
george.honma.ext@areva.com (George Honma)
greg.gibson@unistarnuclear.com (Greg Gibson)
james.p.mcquighan@constellation.com (Jim McQuighan)
james1.beard@ge.com (James Beard)
jerald.head@ge.com (Jerald G. Head)
Joseph_Hegner@dom.com (Joseph Hegner)
judy.romine@areva.com (Judy Romine)
KSutton@morganlewis.com (Kathryn M. Sutton)
kwaugh@impact-net.org (Kenneth O. Waugh)
lchandler@morganlewis.com (Lawrence J. Chandler)
Len.Gucwa.ext@areva.com (Len Gucwa)
maria.webb@pillsburylaw.com (Maria Webb)
mark.beaumont@wsms.com (Mark Beaumont)
mark.t.hunter@unistarnuclear.com (Mark Hunter)
matias.travieso-diaz@pillsburylaw.com (Matias Travieso-Diaz)
mcintyba@westinghouse.com (Brian McIntyre)
media@nei.org (Scott Peterson)
mjcaverly@ppl.web.com (Michael Caverly)
MSF@nei.org (Marvin Fertel)
nirsnet@nirs.org (Michael Mariotte)
Nuclaw@mindspring.com (Robert Temple)
patriciaL.campbell@ge.com (Patricia L. Campbell)
paul.gaukler@pillsburylaw.com (Paul Gaukler)
Paul@beyondnuclear.org (Paul Gunter)
pbessette@morganlewis.com (Paul Bessette)
pedro.salas@areva.com (Pedro Salas)
RJB@NEI.org (Russell Bell)
rrsgarro@pplweb.com (Rocco Sgarro)
ryan_sprengel@mnes-us.com (Ryan Sprengel)
sabinski@suddenlink.net (Steve A. Bennett)
sfrantz@morganlewis.com (Stephen P. Frantz)
Sherry.Mcfaden@areva.com (Sherry McFaden)

DC AREVA - EPR Mailing List

Email
SRubin@numarkassoc.com (Stuart Rubin)
stephan.moen@ge.com (Stephan Moen)
Steve.Graham@hse.gsi.gov.uk (Steve Graham)
strambgb@westinghouse.com (George Stramback)
Tiffany.Wills@areva.com (Tiffany Wills)
tkkibler@scana.com (Tria Kibler)
Tony.Robinson@areva.com (Tony Robinson)
trsmith@winston.com (Tyson Smith)
Vanessa.quinn@dhs.gov (Vanessa Quinn)
vijukrp@westinghouse.com (Ronald P. Vijuk)
Wanda.K.Marshall@dom.com (Wanda K. Marshall)
wayne.marquino@ge.com (Wayne Marquino)
whorin@winston.com (W. Horin)

U.S. NUCLEAR REGULATORY COMMISSION
OFFICE OF NEW REACTORS
DIVISION OF CONSTRUCTION INSPECTION AND OPERATIONAL PROGRAMS
VENDOR INSPECTION REPORT

Docket No.:	05200020
Report No.:	05200020/2013-202
Vendor:	AREVA NP Inc. 3315 Old Forest Road P.O. Box 10935 Lynchburg, VA 24506-0935
Vendor Contact:	Mr. Ray Lewis AREVA Regulatory Affairs ray.lewis.ext@areva.com 410-369-3132
Nuclear Industry Activities:	AREVA has completed their aircraft impact assessment of the U.S. EPR reactor design certification to comply with the U.S. Nuclear Regulatory Commission (NRC) requirements in Title 10 of the *Code of Federal Regulations* (10 CFR) 50.150, "Aircraft Impact Assessment."
Inspection Dates:	July 22–26, 2013
Inspectors:	Stacy Smith, Team Leader, NRO/DCIP/EVIB Eugene Huang, NRO/DCIP/EVIB Larry Wheeler, NRO/DSRA/BPTS Robert Vettori, NRO/DSRA/BPFP Ryan Nolan, NRO/DSRA/BPFP George Thomas, NRO/DE/SEB2 Dr. J. Guadalupe Argüello, Sandia National Laboratory Dr. Alexander L. Brown, Sandia National Laboratory
Approved by:	Richard A. Rasmussen, Chief Electrical Vendor Inspection Branch Division of Construction Inspection and Operational Programs Office of New Reactors

EXECUTIVE SUMMARY

AREVA Inspection Report No.: 05200020/2013-202

The U.S. Nuclear Regulatory Commission (NRC) conducted this inspection to verify that AREVA had implemented the provisions of Title 10 of the *Code of Federal Regulations* (10 CFR) 50.150, "Aircraft Impact Assessment," and performed a design-specific assessment[1] of the effects on the facility of the impact of a large commercial aircraft.

The NRC conducted the inspection at the AREVA facility in Lynchburg, VA, July 22–26, 2013.

The following served as the bases for the NRC inspection:

10 CFR 50.150

During this inspection, the NRC inspection team implemented Inspection Procedure (IP) 37804, "Aircraft Impact Assessment," dated February 9, 2012.

This inspection was performed to verify that AREVA's aircraft impact assessment (AIA) of the U.S. evolutionary power reactor (EPR) design complies with the requirements of 10 CFR 50.150 and to ensure consistency with the industry guidance documented in Nuclear Energy Institute (NEI) 07-13, "Methodology for Performing Aircraft Impact Assessments for New Plant Designs," Revision 8, dated April 2011. Revision 8 of NEI 07-13 has been endorsed by the NRC in Regulatory Guide (RG) 1.217, "Guidance for the Assessment of Beyond-Design-Basis Aircraft Impacts," as one means of performing an AIA acceptable to the NRC.

The NRC inspection team concluded that the portions of the AREVA U.S. EPR AIA reviewed by the NRC inspection team comply with the applicable requirements of 10 CFR 50.150. The results of the inspection are summarized below.

Systems-Loss Assessment

The NRC inspection team concluded that the system-loss assessment performed by AREVA for the AIA is consistent with the regulatory requirements of 10 CFR 50.150.

Fire Damage Assessment

The NRC inspection team concluded that the fire damage assessment performed by AREVA for the AIA is consistent with the regulatory requirements of 10 CFR 50.150.

Structural Damage Assessment

The NRC inspection team concluded that the structural damage assessment performed by AREVA for the AIA is consistent with the regulatory requirements of 10 CFR 50.150.

[1] By a ''design-specific'' assessment, the NRC means that the impact assessment must address the specific design of the facility that is either the subject of a construction permit, operating license, standard design certification, standard design approval, combined license, or manufacturing license application (see 74 FR 28129; June 12, 2009).

Documentation and Quality Assessment

The NRC inspection team concluded that the documentation and quality assessment performed by AREVA for the AIA is consistent with the regulatory requirements of 10 CFR 50.150.

REPORT DETAILS

1. Systems-Loss Assessment

   a. Inspection Scope

   The NRC inspection team reviewed the following activities for AREVA's U.S. EPR AIA systems-loss assessment:

   - verification of the location of key structures, systems, and components (SSC) that provide core cooling or containment isolation, and spent fuel pool (SFP) integrity to determine the potential for damage by aircraft impact
   - verification that key SSCs would be capable of performing their intended function given the established structural, shock, and fire damage footprints and the rule sets and assumptions provided in NEI 07-13
   - verification that AREVA addressed accident initiators, such as a breach of the reactor coolant system (RCS) or the failure of the reactor to trip, that could result from damage caused by an aircraft impact
   - verification that success paths for core cooling exist

   b. Observations and Findings

   b.1 Determination of the location of key SSCs

   The NRC inspection team verified that redundant safety systems are physically separated into four divisions, which protect the individual integrity of the electrical and mechanical safety systems. In addition, the NRC inspection team verified that key SSCs are contained and protected in structures that have hardened and isolated shield structures, hardened exteriors, or are physically separated and redundant.

   The NRC inspection team compared the descriptions of SSCs in the AIA to those in Revision 5 of the U.S. EPR Tier 2 final safety analysis report (FSAR) and verified that the SSCs credited in the assessment were included in the FSAR. The NRC inspection team used equipment location data to confirm that the locations of equipment documented in the assessment report were accurate.

   The NRC inspection team verified that documentation is current to develop and identify spatial information (e.g., internal events probabilistic risk assessment (PRA), internal flooding analysis, internal fire analysis and building layout diagrams).

   b.2 Determination of the state of SSCs in the aircraft impact scenarios

   The NRC inspection team verified that AREVA appropriately identified SSCs that will remain capable to perform their intended function following an aircraft impact. Before the impact of an aircraft, and to minimize the effect of cross-divisional damage, the NRC inspection team noted that the analysis assumes main control room operator action to separate potentially cross-connected divisions of the safety

chilled water system, component cooling water system, and emergency feedwater system.

AREVA performed 23 evaluations to determine the aircraft crash damage effect on SSCs. The NRC inspection team verified that a success set existed for each evaluation. Specifically, the NRC inspection team verified that decay removal paths exist using steam generators and residual heat removal and that emergency feedwater divisions provided core cooling function through the steam generators with several steam relief paths. The NRC inspection team verified that required support components, such as heating, ventilation, and air conditioning; water storage tanks; instrumentation and controls; and electrical power were available.

The NRC inspection team verified that for SFP cooling, multiple cooling success paths exist to provide cooling. Specifically, the SFP could be cooled using the normal fuel pool cooling and purification system (FPCS) or through evaporative cooling. For all 23 evaluations, the NRC inspection team verified that SFP remains intact, and that at least one FPCS division remains functional for SFP cooling.

b.3 Determination of accident conditions

The NRC inspection team verified that AREVA used appropriate assumptions and scenarios to determine accident conditions. These assumptions were consistent with NEI 07-13 and include:

- AREVA's success criteria and the scenario analysis that addresses initial plant states of 100 percent power and cold shutdown.
- The analysis, which takes no credit for the availability of offsite power.
- AREVA's assumption, as part of its shutdown cooling scenarios, that the non-operating loop of shutdown cooling is out of service for maintenance, the reactor vessel is vented, the water level is at or near the reactor vessel head flange, and the reactor has been shut down for a specified time.
- AREVA's consideration of the possibility of an anticipated transient without scram (ATWS).

Specifically, the NRC inspection team reviewed AREVA's treatment of the following potential accident conditions:

Loss-of-coolant accident inside containment

The NRC inspection team determined that the assessment adequately demonstrated that neither shock damage to the containment nor structural damage inside containment would occur. Therefore, AREVA's assertion was verified that a loss-of-coolant accident (LOCA) inside containment is not a scenario that would result from an aircraft impact.

LOCA outside containment

The NRC inspection team verified that piping connected to the RCS that penetrates containment includes isolation valves that are not susceptible to damage because of their location within hardened structures. Therefore, AREVA's assertion was verified that a LOCA outside of containment is not a scenario that would result from an aircraft impact.

ATWS

The NRC inspection team verified that equipment necessary to trip the reactor is protected from damage by the Safeguards Building 2/3 shield structure and the reactor shield building. In addition, an aircraft impact would not prevent the extra boration system from operating to inject borated water into the RCS to maintain the core subcritical. Therefore, the ability to trip the reactor is maintained and an ATWS is not a scenario that would result from an aircraft impact.

Flooding

The NRC inspection team verified that AREVA adequately assessed the potential for flooding from large water sources. During the inspection, it was unclear how AREVA assessed the potential for flooding of the circulating water cooling tower basin. AREVA personnel clarified that the flooding analysis in the FSAR bounds AIA related flooding events from large water sources, including the circulating water cooling tower basin. Therefore, flooding from large water sources from an aircraft impact would not compromise the nuclear island. AREVA initiated an AIA document amendment (159-7015072-000, dated July 25, 2013) to clearly document how flooding was addressed in the AIA.

Loss of Decay Heat Removal

The NRC inspection team verified that AREVA adequately assessed the potential for a loss of decay heat removal event during plant shutdown. Specifically, the NRC inspection team verified that design features relied upon (i.e., physical separation and redundancy) if the normal decay heat removal system is damaged are sufficiently diverse to be relied upon for core cooling.

b.4 Identification of Success Paths

The NRC inspection team verified the methodology used by AREVA established success paths for core cooling. The NRC inspection team noted that AREVA used target set analysis results as the basis for developing success paths for AIA. The target set analysis is performed in accordance with 10 CFR 73.55(b)(4) to support the design of a physical protection program that can prevent significant core damage and spent fuel sabotage. The NRC inspection team verified that the target set analysis was properly informed by the success criteria developed as part of the Level 1 PRA and that confirmatory analysis of the performance of an equipment set was performed with the modular accident analysis program (MAAP) code. The MAAP code established PRA success for the U.S. EPR Level 1 PRA. The NRC inspection team compared the success set for feed and bleed cooling developed as part of the target set analysis with the corresponding success criteria in the PRA for

feed and bleed cooling and found them to be consistent. The NRC inspection team reviewed the systems analysis for the safety injection system used in the AIA, including system description, success criteria, connected systems, and support systems. The NRC inspection team verified consistency with PRA success criteria for safety injection and that the description of connected and support systems was adequate. In addition, the NRC inspection team reviewed Appendix A of the target set analysis document and determined that success sets had been developed for the full range of plant conditions described in Section 3 of NEI 07-13.

c. Conclusions

The NRC inspection team concluded that the system-loss assessment performed by AREVA for the AIA is consistent with the regulatory requirements of 10 CFR 50.150.

2. Fire Damage Assessment

a. Inspection Scope

The NRC inspection team reviewed the following activities for AREVA's U.S. EPR AIA fire damage assessment:

- verification that the fire damage assessment identifies and incorporates the necessary design features and functional capabilities
- verification that the fire damage assessment is realistic and design-specific
- verification that key design features credited in the AIA are consistent with those documented in the FSAR
- verification that the fire damage assessment includes most limiting scenarios
- verification that damage footprints include the effects from the spread of fire damage through existing connected compartments and through new compartment connections due to overpressure
- verification that SSCs credited for safe shutdown following aircraft impact scenarios remain free from physical and fire damages

b. Observations and Findings

b.1 Fire-damage assessment

The NRC inspection team verified AREVA's method that led them to conclude that the hardened U.S. EPR structural design prevented fire from being a hazard to internal equipment. Specifically, the NRC verified that there was no fire damage caused by aircraft impact in the vicinity of essential SSCs needed to maintain reactor core and SFP cooling. The NRC inspection team verified consistency between the FSAR and AIA to assure that design features credited in the AIA are described in the FSAR.

The NRC inspection team assessed AREVA's preventative measures and credited protections to exterior openings. Specifically, the NRC inspection team verified that AREVA's assessment of credited structural design features, including concrete barriers and 3 hour 5 pounds per square inch differential barriers located at the perimeter of the nuclear island, adequately prevented damage from propagating to the interior protected regions.

b.2 Fire Damage Effects on SSCs

The NRC inspection team reviewed the AIA to determine if AREVA assessed the fire damage effects on SSCs; however, since there were no fire damage areas in the vicinity of essential SSCs needed to maintain reactor core and SFP cooling, the NRC inspection team verified AREVA's preventative measures and credited protections as described in section 2.b.1, "Fire-damage assessment."

c. Conclusions

The NRC inspection team concluded that the fire damage assessment performed by AREVA for the AIA is consistent with the regulatory requirements of 10 CFR 50.150.

3. Structural Damage Assessment

a. Inspection Scope

The NRC inspection team reviewed the following activities for AREVA's U.S. EPR AIA structural damage assessment:

- verification of information found in plant documentation including plant arrangement drawings that display the locations of major equipment, plant elevation drawings that document the relative heights of various buildings, civil-structural drawings that provide wall thicknesses and reinforcement details, and material specifications

- verification of general structural analysis considerations such as design inputs, analyses parameters, and assumptions, computer codes, methods used for structural analyses and results to determine whether AREVA adequately analyzed the effects of and damage to structures resulting from global and local aircraft impact loads

- verification of the containment and SFP impact analyses to determine whether AREVA has met the criteria in RG 1.217 and in Section 2.5 of NEI 07-13

- verification of the structural damage footprint assessments to determine whether AREVA adequately assessed the containment and other reinforced concrete buildings that contain essential SSCs for maintaining reactor core and SFP cooling using the damage rule sets in RG 1.217 and in Section 3.3 of NEI 07-13

b. Observations and Findings

b.1 Structural Assessment Document Review

The NRC inspection team verified plant arrangement drawings displayed the correct locations of major equipment and plant elevation drawings identified the relative heights of various buildings. In addition, the NRC inspection team verified that the civil-structural drawings and AIA design requirements calculations provided correct wall thicknesses, reinforcement details (sizes, spacing, and distribution) and material specifications consistent with the design requirements.

b.2 General Structural Analysis

The NRC inspection team verified that AREVA used the appropriate design inputs including the structural analysis assumptions and limitations, the type of finite elements used in each analysis, material models considered, model mesh refinement, boundary conditions and extent of model, and the time duration of the analysis. In addition, the NRC inspection team verified that AREVA adequately documented and justified the structural design input for a sampling of analysis and adequately analyzed the effects of and damage to structures resulting from local and global loading arising from an aircraft impact.

Specifically, the NRC inspection team reviewed two computer codes used in the structural analysis for the AIA: (1) TeraGrande, a software used for final analyses implementing the ANACAP-U concrete material constitutive model, and (2) SAP2000, used for preliminary analyses. The NRC inspection team verified that AREVA had verified, validated, and benchmarked the code for the applicable class of problems assessed, consistent with Appendix C of NEI 07-13, and adequately documented the validation and verification.

The NRC inspection team reviewed the impact scenarios and subsequent final structural damage analyses and results to verify that AREVA applied appropriate elements, boundary conditions, initial conditions, and time duration for the AIA. In addition, the NRC inspection team verified that the model and mesh refinement used in the structural analyses was sufficient.

The NRC inspection team reviewed a sample of the structural damage impact scenario analyses and verified that AREVA properly applied the NRC-supplied forcing function to the appropriate structural damage impact scenarios. In addition, the NRC inspection team reviewed the assumptions used in the structural damage analyses and verified that AREVA adequately documented the technical basis in the AIA for the assumptions used in the analyses.

The NRC inspection team reviewed a sample of structural damage analyses and verified that AREVA used the correct failure criteria. As part of the review, the NRC inspection team observed that AREVA conservatively excluded increase in strength from concrete aging in its analyses. Appropriate failure strain values of 0.25 percent and 5 percent were used for concrete and reinforcement material, respectively, in the analyses.

The NRC inspection team reviewed the AIA to determine consistency with the design as documented in the FSAR. The inspection team reviewed a sample from the seven critical section[2] calculations that were affected by the AIA and verified that the independent AIA design requirements were considered and bounded in the critical section design evaluations.

b.3 Containment structure and SFP specific impact assessment

The NRC inspection team observed that AREVA used individual, hardened, and isolated shield structures, specific to the containment building and the fuel building housing the SFP, to provide protection from a direct impact from an aircraft crash. Therefore, AREVA evaluated several impact scenarios on the hardened isolated reactor shield building and the fuel building shield structure to address the potential for subsequent damage and to demonstrate integrity of the containment structure and the SFP.

The NRC inspection team reviewed the structural damage assessment as it relates to local loading effect on the containment structure and verified that the following activities were conducted in accordance with approved guidance:

- AREVA documented and cross-checked the aircraft engine parameters used in the analysis against NRC-specified parameters.

- AREVA properly applied the various local loading formulas referenced in NEI 07-13, Subsection 2.1.2, to arrive at the degree of local damage and the wall thickness required to prevent perforation of the target.

The NRC inspection team reviewed the structural damage assessment as it relates to global loading effects on the containment structure. The NRC inspection team verified that the following activities were conducted in accordance with approved guidance:

- AREVA effectively used and documented the application of the force time-history analysis method and cross-checked it for its equivalency to the NRC-specified force time-history.

- For the application of the force time-history analysis method, AREVA properly used and adequately documented the NRC-specified spatial distribution of the impact force in the analyses.

The NRC inspection team reviewed a sample of documents for material characterization and failure criteria related to the structural damage assessment and verified that the following analysis activities were conducted in accordance with approved guidance:

- AREVA used the ANACAP-U concrete constitutive model consisting of material properties and equations used to model the nonlinear behavior of

[2] Critical sections are those portions of individual Seismic Category I structures credited in prevention or mitigation of consequences of postulated design basis accidents, or experience the largest structural demands during design basis conditions, or needed for evaluation of an essentially complete design.

both steel and concrete materials in the analyses. The steel components, including reinforcement, were modeled with appropriate elasto-plasticity models. The model parameters used are adequately documented and consistent with the material properties and equations documented in NEI 07-13, Section 2.3.

- AREVA properly applied the dynamic increase factors specified in NEI 07-13, Subsection 2.3.1, for the various materials used in the analyses.

- AREVA properly applied the ductile failure strain limits specified in NEI 07-13, Subsection 2.3.2, for the various materials used in the analyses.

- The concrete structural failure criteria used in the analyses are appropriately documented and consistent with the criteria specified in NEI 07-13, Subsection 2.3.3.

- AREVA properly applied the material models specified in NEI 07-13, Subsection 2.3.4.

- AREVA properly applied and adequately documented the structural integrity failure criteria specified in NEI 07-13, Subsection 2.3.5.

The NRC inspection team reviewed NEI 07-13, Section 2.4, regarding the major assumptions applied to the containment and SFP related structural analyses and verified that the following activities were conducted in accordance with approved guidance:

- The force time-history analysis model properly assumed that the aircraft impact strike was perpendicular to the centerline of the isolated reactor shield building (surrounding the containment) and walls of other shield structures including the fuel building shield structure (surrounding the fuel building in which the SFP is located).

- AREVA justified that, for the reactor shield building, the dome or spring-line impact was a less critical impact location compared to a strike at about mid-height of the exposed portion of the cylindrical wall.

- Containment regions and other nuclear island structures containing critical penetrations received an appropriate level of special consideration.

- AREVA assessed potential aircraft impact at other locations that could result in critical consequences.

The NRC inspection team reviewed NEI 07-13, Section 2.5, regarding the sufficiency criteria applied to the containment structure and the SFP analyses and verified that the following activities were conducted in accordance with approved guidance:

- The containment was concluded to remain intact, consistent with the sufficiency criteria in NEI 07-13, Subsection 2.5.1.

- The integrity of the SFP was concluded to remain maintained, consistent with the sufficiency criteria in NEI 07-13, Subsection 2.5.2.

b.4 Structural damage footprint assessment

The NRC inspection team reviewed the structural damage footprint analyses to determine that the following criteria related to the damage rule sets identified in NEI 07-13, Section 3, have been met. The NRC inspection team reviewed the structural damage rule sets and verified that the following activities were conducted in the analyses:

- Structures of concern that contain SSCs have been identified.
- A systematic evaluation of susceptible damage and vulnerabilities was conducted and adequately documented.
- Assumptions used to determine elevations of concern have been addressed and adequately documented.
- Each external face of each building exposed to a direct hit has been divided into two categories, containment structure and other reinforced concrete buildings; and has been analyzed and adequately documented.

The NRC inspection team verified that structural damage rule sets for containment structures were appropriately assessed consistent with the guidance in NEI 07-13, Subsection 3.3.1.

The NRC inspection team reviewed the structural damage rule sets for reinforced concrete buildings for consistency with the guidance in NEI 07-13, Subsection 3.3.2, and verified that the following activities were conducted in the analyses:

- Various impact points have been investigated and documented in order to define the damage footprint.
- Structural damage rule sets regarding perforations were appropriately developed.
- Shock damage was evaluated in the structural damage footprints and these evaluations have been adequately documented.

c. Conclusions

The NRC inspection team concluded that the structural damage assessment performed by AREVA for the AIA is consistent with the regulatory requirements of 10 CFR 50.150.

4. AIA Documentation and Quality Assessment

a. Inspection Scope

The NRC inspection team reviewed the following activities for AREVA's U.S. EPR AIA quality assurance assessment:

- verification that AREVA adequately documented quality assessment consistent with NEI 07-13, Section 5.1

- verification that AREVA adequately established standards and measures to establish the validity of the assessment and supporting calculations consistent with 10 CFR 50.150

b. Observations and Findings

b.1 Documentation

During its review of the AIA documentation, the NRC inspection team verified that the FSAR included a description of the design features and function capabilities credited in the AIA. In addition, the NRC inspection team verified that AREVA's documentation was sufficiently complete to support the inspection.

b.2 Quality Requirements

The NRC inspection team noted that AREVA did not create a separate quality plan for the use of the AIA. Instead, a compilation of AREVA's quality assurance documents identified and defined quality elements intended to meet the standards and measures identified in NEI 07-13. 1717-06, "Corrective Action Program—WebCAP," was used to document and evaluate any conditions adverse to quality. Those related to the AIA were fed into AREVA's design change control process, which is governed by EPR-EN-PR-1003, "Design Change Control Process." The AREVA design change process established links to applicable documents for AREVA to revise. AREVA's design change control process has a screen to evaluate whether a design change will impact the AIA.

The NRC inspection team reviewed a sample of AREVA's design change requests (DCR) and verified that appropriate DCRs were included in the AIA. The inspection team verified that DCRs related to the AIA followed the design control process and all changes to applicable documents were updated. The NRC inspection team verified that the inputs, assumptions, methodology, assessment results, and conclusions were applied consistent with AREVA's quality assurance documents.

b.3 Software

The NRC inspection team reviewed the control of the ANATECH concrete material modeling software, ANA-CAP-U, incorporated into the TeraGrande explicit dynamics finite element software. ANA-CAP-U is used to evaluate the structural performance of the U.S. EPR shield building design. The NRC inspection team verified that the material model was verified and benchmarked with data for impact tests on concrete structural components. The NRC inspection team also verified that the ANSYS static

model development for seismic analysis related to the critical sections adequately incorporated design change inputs and assumptions. The NRC inspection team determined that the software and modeling methods used to perform the structural analysis, seismic analysis, and dimensional modeling were adequate to perform the AIA.

c. Conclusions

The NRC inspection team concluded that the documentation and quality assessment performed by AREVA for the AIA is consistent with the regulatory requirements of 10 CFR 50.150.

5. Entrance and Exit Meetings

On July 22, 2013, the NRC inspection team discussed the scope of the inspection with Mr. Tony Robinson and other representatives from AREVA. On July 26, 2013, the NRC inspection team presented the inspection results and observations during an exit meeting with Mr. Robinson and other representatives from AREVA.

ATTACHMENT

1. PERSONS CONTACTED

Name	Title / Inspection Area	Affiliation	Entrance	Exit	Interviewed
Ray Lewis	Licensing Lead	AREVA	X	X	X
George Pannell	Fire Control Lead	AREVA	X	X	X
David K. White	Reg. Affairs	AREVA	X		X
Doug Schweers	Security Manager	Unistar	X		
Fred Maas	Systems Engineer	AREVA	X		X
Pedro Salas	Director, Reg. Affairs	AREVA	X	X	
Michael S. Carpenter	VP, Design Engineering	AREVA	X	X	
James M. Bonfiglio	Manager, Operations	AREVA	X	X	
Randy Ford	Advisory Engineer	AREVA	X	X	X
Bethany Coffey	Administrative Assistant	AREVA	X	X	
Brad Chamberlain	Fire Protection Engineer	AREVA	X	X	X
Mel Hess	Electrical Systems Supervisor	AREVA	X		
Scott Groesbeck	Fire Protection Manager	AREVA	X	X	X
Paul Byron	Licensing	AREVA	X		X
Todd Oswald	Technical Consultant	AREVA	X	X	X
Michael P Saniuk	Quality Engineering Oversight, Manager	AREVA	X		
Ronda Pederson	Licensing / Structural	AREVA	X	X	X
Charles Tally	Engineering Manager	AREVA	X		
Thomas Ehrhorn	Quality Engineer	AREVA	X		
Tony Robinson	VP NB	AREVA	X	X	
Randy J. James	AREVA Consultant	ANATECH		X	X
Serge Naboyshchykov	C/S Engineer	AREVA Contractor		X	

2. Inspection Procedures Used

Inspection Procedure 37804, “Aircraft Impact Assessment,” dated February 9, 2012.

2. List of Items Opened, Closed, and Discussed

The NRC has not performed any previous inspections of the AREVA U.S. EPR AIA.

3. Documents Reviewed

Documentation and Quality Assessment

- 38-9112263-002, “ANA-08-0737 Evaluation of Aircraft Impact on AREVA EPR Plant Design,” Revision 3 dated August 29, 2011
- 38-9112263-002, “ANA-08-0737 Evaluation of Aircraft Impact on AREVA EPR Plant Design,” Revision 3 dated August 29, 2011
- Condition Report (CR) 2010-2749, April 22, 2010
- CR 2011-4978, July 19, 2011
- CR 2013-1929, March 9, 2013
- CR 2013-1930, March 9, 2013
- CR 2013-1931, March 9, 2013
- CR 2013-1932, March 9, 2013
- CR 2013-2846, April, 10, 2013
- CR 2010-9232, December 20, 2010
- CR 2009-3535, June 5, 2009
- CR 2009-3601, June 8, 2009
- CR 2008-4746, September 3, 2008
- CR 2013-1933, March 9, 2013
- DCD-AGA-1UJH-3200, “EPR design certification project general arrangement drawing safeguard building division 1 plan at elevation +/-0 feet,” Revision 1
- DCD-AGA-2UJH-3200-A0-007, “EPR design certification project general arrangement drawing safeguard building division 2&3 plan at elevation +0’-0”,” Revision 0
- DCD-AGA-2UJH-3200-A0-007, “EPR design certification project general arrangement drawing safeguard building division 2&3 plan at elevation +0’-0”,” Revision 1
- DCD-AGA-2UJH-3200-A0-007, “EPR design certification project general arrangement drawing safeguard building division 2&3 plan at elevation +0’-0”,” Revision 7
- DCD-AGA-UFA-3400, “EPR design certification project general arrangement drawing fuel building plan at elevation +64’-0”,” Revision 5
- DCD-AGA-UFA-3400, “EPR design certification project general arrangement drawing fuel building plan at elevation +64’-0”,” Revision 6
- DCD-AGA-UFA-3440, “EPR design certification project general arrangement drawing fuel building plan at elevation +79’-5”,” Revision 4
- DCD-AGA-UFA-3440, “EPR design certification project general arrangement drawing fuel building plan at elevation +79’-5”,” Revision 5
- DCD-AGA-UFA-3490, “EPR design certification project general arrangement drawing fuel building plan at elevation +90’-11”,” Revision 3
- DCD-AGA-UFA-3490, “EPR design certification project general arrangement drawing fuel building plan at elevation +90’-11”,” Revision 4
- DCD-AGA-4UJK-7000-A0-007, “EPR design certification project general arrangement drawing safeguard building division 4 section A-A,” Revision 1
- DCD-AGA-4UJK-7000-A0-007, “EPR design certification project general arrangement drawing safeguard building division 4 section A-A,” Revision 2
- DCD-AGA-4UJK-7000-A0-007, “EPR design certification project general arrangement drawing safeguard building division 4 section A-A,” Revision 7
- DCD-CGE-1UJH-3200-A0-001, “EPR design certification project dimensional arrangement drawing safeguard building division 1 plan at elevation +0.0,” Revision 1

- DCD-CGE-1UJH-3200-A0-001, “EPR design certification project dimensional arrangement drawing safeguard building division 1 plan at elevation +0.0,” Revision 3
- DCD-CGE-2UJH-3200-A0-000, “EPR design certification project dimensional arrangement drawing safeguard building division 2&3 plan at elevation +0.0,” Revision 0
- DCD-CGE-2UJH-3200-A0-000, “EPR design certification project dimensional arrangement drawing safeguard building division 2&3 plan at elevation +0.0,” Revision 1
- DCD-CGE-4UJH-3200-A0-001, “EPR design certification project dimensional arrangement drawing safeguard building division 4 plan at elevation +0.0,” Revision 1
- DCD-CGE-UFA-3400, “EPR design certification project dimensional arrangement drawing fuel building plan at elevation +64’-0”,” Revision 4
- DCD-CGE-UFA-3400, “EPR design certification project dimensional arrangement drawing fuel building plan at elevation +64’-0”,” Revision 5
- DCD-CGE-UFA-3440, “EPR design certification project dimensional arrangement drawing fuel building plan at elevation +79’-5”,” Revision 4
- DCD-CGE-UFA-3440, “EPR design certification project dimensional arrangement drawing fuel building plan at elevation +79’-5”,” Revision 5
- DCD-CGE-UFA-3490, “EPR design certification project dimensional arrangement drawing fuel building plan at elevation +90’-11”,” Revision 3
- DCD-CGE-UFA-3490, “EPR design certification project dimensional arrangement drawing fuel building plan at elevation +90’-11”,” Revision 4
- DCD-CGE-4UJK-7000-A0-001, “EPR design certification project dimensional arrangement drawing safeguard building division 4 section A-A,” Revision 1
- 113-9029339-000, “US EPR various concrete sections thickness/height changes,” August 16, 2007
- 113-9043231-000, “Interior/exterior door reduction,” June 20, 2007
- 113-7010029-000, “Electrical changes to US EPR FSAR Table 3.2.2-1 (WebCap 2010-4794),” March 18, 2011
- 113-7007992-000, “CCWS DC design change for RAI 406, Q9.2.2-114,” September 30, 2010
- 113-7003882-000, “Safeguard building 1 and 4 spiral staircase modification,” April 2, 2010
- 113-7013497-000, “Fire barrier changes to improve plant response to beyond design basis fire,” March 13, 2013
- 113-7013559-000, “Fire barrier improvements to nuclear island stair towers for beyond design basis fire,” May 1, 2013
- 113-7014579, “AIA barrier updates,” June 10, 2013
- 113-7013440-000, “Change ESWS valves 30PEB80 AA003, AA004, AA013, and AA014 from local manual actuation to MOVs that are operable from SA controls,” March 18, 2013
- 113-7000500-000, “Changes to AGA drawings for CR 2009-3535 and -3601,” October 19, 2009
- Document release notice (DRN)-C44600033330, March 19, 2008
- DRN-41951, May 2, 2008
- DRN-41951, March 3, 2008
- 32-9119150-002, “Structural assessments of aircraft impact on us EPR standard plant
- computer code SAP2000-V10 validation and verification,” Revision 2
- 32-9025669-009, “US EPR standard plant nuclear island soil-structure interaction analysis,” March 12, 2013
- 32-9011967-011, “US EPR standard plant structural loads – seismic loads,” June 5, 2013

- 32-9015773-007, “Static structural analysis of the EPR nuclear island common basemat structure,” May 27, 2010
- 32-7000853-005, “Development of finite element model for soil-structure interaction analysis for U.S. EPR design certification,” Revision 5
- 32-9119150-002, “Structural assessments of aircraft input on US EPR standard plant,” June 13, 2013
- EPR-EN-PR-1002, “Design control process,” Revision 1, April 1, 2010
- EPR-EN-PR-1013, “Interdisciplinary coordination and review process,” Revision 2, September 2, 2010
- 1717-06, “Corrective Action Program – WebCAP,” Revision 8, April 11, 2013
- 0902-28, “Development of engineering applications software,” Revision 4, August 29, 2012
- 0902-30, “Management and use of engineering applications software,” Revision 6, September 14, 2012
- Purchase order (PO) #1013027150, AREVA to Anatech, April 5, 2013
- PO #1011047789, AREVA to Anatech, July 22, 2011
- PO #1008010839, AREVA to Anatech, May 1, 2008
- 21-9119150-001, “Structural assessments of aircraft impact on us EPR standard plant,” Revision 1

Fire Damage Assessment

- AREVA 51-9116544-002, “Aircraft Crash Hazard Analysis,” Revision 2
- ANP-10317, “Design Requirements for the U.S. EPR Aircraft Hazard Protection Structures Technical Report,” Revision 1, April 2013
- ANP-10296, “U.S. EPR Design Features that Enhance Security Technical Report,” Revision 1, April 2013
- “U.S.EPR Final Safety Analysis Report Chapter 9A Fire Protection Analysis,” Revision 4, November 15, 2012

Structural Damage Assessment

- US EPR Tier 2 FSAR, Revision 5, Section 1.6 and Section 19.2.7
- AREVA SGI Document No. 51-9116544-002, Aircraft Crash Hazard Analysis, June 2013, US EPR EIR
- AREVA SGI Document No. 32-9119150-002, Structural Assessments of Aircraft Impact on US EPR Standard Plant, AREVA Calculation
- AREVA SGI Document No. 38- 9112263-002, August 29, 2011, Evaluation of Aircraft Impact on AREVA EPR Plant Design – Structural Response Analyses, [ANATECH Corp Report No. ANA-08-0737, Revision 3, August 2011]
- SGI Letter dated 12-21-2007 from David B Mathews, USNRC to James R. Ford AREVA NP regarding Approval of AREVA NP Inc Safeguards Protection Program and Reviewing Official, and Transmittal of Beyond Design-Basis Large Commercial Aircraft Characteristics specified by the Commission
- NEI 07-13, Appendix A [SGI], “Safeguards Values for Use in Section 3 Methodology”
- AREVA Document EIR 51-7000669-004, Revision 4, Requirements for the Aircraft Hazard Protection Structures Design in Typical US EPR Plant, June 14, 2013
- AREVA Technical Report ANP-10317, Revision 2, Design Requirements for the US EPR Aircraft Hazard Protection Structures

- AREVA Technical Report ANP-10295, Revision 2, U.S. EPR Design Features that Enhance Security
- AREVA Drawing DCD-CGE-UZT-3002, Revision 004, EPR Design Certification Project, Dimensional Arrangement Reference Plant Building Location Drawing
- AREVA Proprietary 3D Evaluation Model – 3D Figures
- AREVA Document EPR-EN-TG-2170, Revision 2, Format of FSAR, Appendix 3E Critical Sections, US EPR Civil/Structural Technical Guide, 10/19/2012
- AREVA Calculation 32-9029345-001, US EPR Standard Plant DC Reactor Shield Building Design – Dome to Wall Transition (CS-20)
- AREVA Calculation 32-7012540-001, US EPR Standard Plant DC Fuel Building Design – Hardened Shell – Material Lock Area Roof Slab & Support Walls (CS-21)
- AREVA Calculation 32-7004071-001 EPR Standard Plant DC Fuel Building Design – Hardened Shell – Wall from Top of NI Basemat to Grade (CS-16)
- AREVA Procedure EPR-EN-PR-1003-003, Design Change Control Process, Revision 3, 11/30/2011
- AREVA Document - Design Change Request (DCR) 113-7014578-000 dated June 12, 2013, Spent Fuel Cask Transfer Facility Design Requirements for AIA
- AREVA Document - DC Licensing Document Approval RAI 565 Response dated June 17, 2013, approved FSAR change.
- AREVA Document 2013-2846-CR Process Status Review (open)
- AREVA Administrative Procedure 0418-01 R7, Preparation, Control and Revisions to FSAR 10-4-12
- ANATECH Corporation Memo from Randy James to Bob Kennedy (Structural Mechanics Associates) and Bob Nickell (Applied Science and Technology) regarding “Test for Shear Failure in Beam,” provided via email on January 31, 2003
- ANATECH Internal Document - TeraGrande/ANACAP-U Software Test Problems Report
- AREVA Technical Report ANP-10317, Revision 3, Design Requirements for the US EPR Aircraft Hazard Protection Structures [Security Sensitive**]**, July 2013, [Provided in AREVA ERR]
- US EPR Tier 2 FSAR, Interim Revision 6, Mark-up of pages affected in response to DCR-113-7014578-000 (i.e., Table 1.6-1 (page 1.6-40; Section 9.1.4 (pages 9.1-47, 58, 59, 62, 63, 64, 67, 71, 74 & 75) and Section 19.2 (page 19.2-77)) [Provided in AREVA ERR]
- Letter NRC:13:068 dated August 1, 2013 from Pedro Salas, AREVA NP Inc, to USNRC regarding AREVA NP Inc. Technical Report ANP-10317, Revision 3, “Design Requirements for the US EPR Aircraft Protection Structures” and Associated Revised FSAR Pages; with Enclosures: (i) SUNSI Version of ANP-10317, Revision 3, (ii) Public Version of ANP-10317, Revision 3, and (iii) Revise pages of FSAR, Interim Revision 6, reflecting the subject design change request [ADAMS Accession Nos. ML13218A006, ML13218A007, and ML13218A008 all non-publicly available]

Systems-Loss Assessment

- AREVA, "Aircraft Crash Hazard Analysis," 51-9116544-002, Revision 2, dated June 2013 (Safeguards Information)
    - Appendix A: Success Set
    - Appendix B: Susceptibility and Vulnerabilities Analysis
    - Appendix C: Damage Footprint
    - Appendix D: Aircraft Crash Damage Results

    - Appendix E: Supplemental Description of Modeling Using in Anatech Corp. AIA Structural Evaluations
    - Appendix F: Main Steam Line Proof of Concept and Sample Calculations
    - Appendix O: U.S. EPR Systems Important to Preventing of Mitigating Core Damage
    - Appendix P: System Drawings
- AREVA, "U.S. EPR Design Features that Enhance Security," ANP-10296, Revision 2, date June 2013
- AREVA, "Target Set Analysis," 51-9036187-003, Revision 3, dated July 2012
- AREVA, "U.S. EPR Systems Important to Preventing or Mitigating Core Damage", 51-7011021-002, Revision 2